Sampling and Analysis of Impact Crater Residues found on the Wide Field Planetary Camera-2 Radiator

A. T. Kearsley, Science Facilities, Natural History Museum, London, United Kingdom.
G. W. Grime, J. L. Colaux, C. Jeynes, V. V. Palitsin, and R.P. Webb, Ion Beam Centre, University of Surrey, Guildford, United Kingdom.
T. J. Griffin and B. B. Reed, NASA Goddard Space Flight Center, Greenbelt, Maryland, USA.
P. D. Anz-Meador, J.-C. Liou, D. Ross, G. A. Robinson and J. N. Opiela, NASA Johnson Space Center, Houston, Texas, USA.
L. Gerlach, European Space Agency, Noordwijk, The Netherlands.

After nearly 16 years on orbit, the Wide Field Planetary Camera-2 (WFPC-2) was recovered from the Hubble Space Telescope in May 2009 during the 12 day shuttle mission designated STS-125. During that exposure to the low Earth orbit environment, the WFPC-2 radiator was struck by approximately 700 impactors producing crater features 300 μm and larger in size. Following an optical inspection of these features in 2009, an agreement was reached for the joint NASA-ESA examination and characterization of crater residues, the remnants of the projectile, in 2011. Active examination began in 2012, with 486 of the impact features being cored at NASA Johnson Space Center's (JSC) Space Exposed Hardware cleanroom and curation facility. The core samples were subsequently divided between NASA and ESA. NASA's analysis was conducted at JSC's Astromaterials Research and Exploration Science (ARES) Division, using scanning electron microscopy (SEM)/ energy dispersive X-ray spectrometry (EDS) methods, and ESA's analysis was conducted at the Natural History Museum (NHM) again using SEM/EDS, and at the University of Surrey Ion Beam Centre (IBC) using ion beam analysis (IBA) with a scanned proton microbeam.

As detailed discussion of the joint findings remains premature at this point, this paper reports on the coring technique developed; the practical taxonomy developed to classify residues as belonging either to anthropogenic "orbital debris" or micrometeoroids; and the protocols for examination of crater residues. Challenges addressed in coring were the relative thickness of the surface to be cut, protection of the impact feature from contamination while coring, and the need to preserve the cleanroom environment so as to preclude or minimize cross-contamination. Classification criteria are summarized, including the assessment of surface contamination and surface cleaning.

Finally, we discuss the analytical techniques used to examine the crater residues. We employed EDS from either electron excitation (SEM-EDS) and, in a minority of cases for cores assessed as "difficult" targets, proton excitation (IBA). All samples were documented by electron imagery: backscattered electron imagery in the SEM, and where appropriate, secondary electron imagery during IBA.